PATENT ABSTRACTS OF JAPAN

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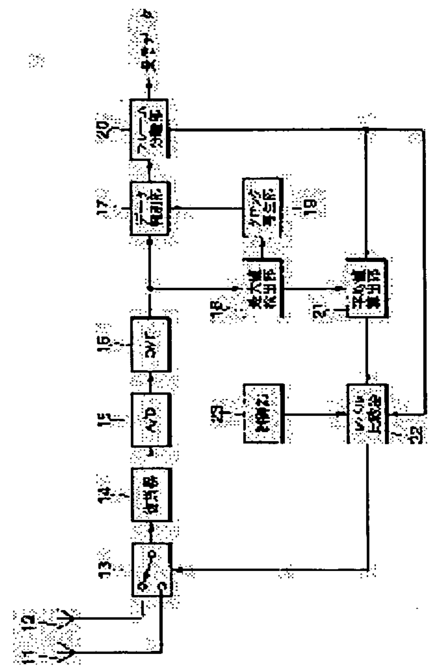
(54) DIVERSITY RECEIVER

(57)Abstract:
PROBLEM TO BE SOLVED: To provide a diversity receiver with excellent resistance to interference and a simple configuration.
SOLUTION: The diversity receiver is provided with a plurality of antennas (11, 12), an antenna changeover device (13) that selects one of the plurality of the antennas (11, 12) and switches the connection, a demodulator (14) that demodulates the wireless signal to obtain a band spread spectrum signal, an analog/digital converter (15) that applies analog/digital conversion to the band spread spectrum signal to generate chip data, a digital matched filter (16) that obtains a correlation value between the chip data and the spread code, a maximum correlation value detection section (18) that detects a maximum correlation value, a mean value calculation section (21) that obtain a mean value of the maximum correlation value per frame, and a level comparator (22) that compares the mean value with a predetermined threshold value to output a control signal to control the antenna switching in the antenna changeover device (13) to the antenna changeover device (13).



LEGAL STATUS

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[Date of registration]

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[Date of extinction of right]

CLAIMS

[Claim(s)]
[Claim 1] An antenna changer which chooses any or 1 of two or more antennas for carrying out diversity reception of the electric wave, and two or more antennas, and performs a connection change, The recovery section which restores to a radio signal obtained through an antenna connected by antenna changer, and acquires a spectrum diffusion signal, A correlation value detection means to calculate a correlation value of said spectrum diffusion signal and diffusion sign, The averaging section which calculates the average per frame of the maximum correlation value which a correlation value detection means outputs, Diversity reception equipment which compared a threshold beforehand determined as said average which the averaging section outputs, and was equipped with a level comparator which outputs a control signal for controlling an antenna change in an antenna changer to an antenna changer.
[Claim 2] Said antenna changer is diversity reception equipment according to claim 1 which changes an antenna into a guard time contained in a frame.
[Claim 3] Said correlation value detection means is diversity reception equipment according to claim 1 or 2 which is a digital matched filter.

[Translation done.]

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DETAILED DESCRIPTION

[Detailed Description of the Invention]
[0001]
[The technical field to which invention belongs] This invention relates to the antenna change diversity reception technology used for spread spectrum direct sequence communication system.
[0002]
[Description of the Prior Art] In the radio communications using a digital cellular phone, a land mobile radiotelephone, etc., an input signal causes the increment in a lifting and a digital error for the level variation and phase fluctuation which are about dozens of dB by phasing which originates under migration and multi-pass environment of a migration communication terminal. For this reason, technology, such as after [detection] change diversity and antenna change diversity, is proposed as technology for compensating the fall of receiving level. In the diversity after detection, it is the method which adopts the data which formed an antenna and two or more receivers which restore to the received electric wave and reproduce received data in the receiving set, performed data playback in each receiving network, and was most reproduced in the high receiving network of receiving level. However, since the change diversity after detection needs two or more receiving networks, it has the defect to which the configuration of a receiving set becomes complicated and a manufacturing cost becomes high. For this reason, it is unsuitable for the digital cellular phone as which low cost and a simple configuration are required.
[0003] Then, antenna change diversity is proposed as technology for realizing diversity with low cost and a simple configuration. An example of antenna change diversity reception technology is explained with reference to drawing 6 . The diversity reception equipment shown in this drawing is indicated by JP,2000-295150,A. In this drawing, the antenna changer to which signs 27 and 28 perform an antenna and 29 performs an antenna change, and 30 receive the electric wave from a base station through an antenna 27 or 28, are a receive section which gets over and outputs received data, and have the function to detect input-signal reinforcement. 31 is an antenna selection means and controls an antenna changer 29 according to the level of the input signal detected in the receive section 30. The antenna selection means 31 measures the low pass filter 32 which filters input-signal reinforcement, a threshold generating means 33 output the suitable change threshold over average input-signal reinforcement, and the change threshold and the input-signal reinforcement obtained from the threshold generating means 33, when input-signal reinforcement changes and it is less than a threshold, is equipped with a comparison means 34 control an antenna changer 29 to change an antenna, and is constituted.
[0004] What has the cut off frequency of the Doppler change frequency degree which produces a low pass filter 32 on a received wave with the passing speed of a walking speed degree is used. The change threshold which the threshold generating means 33 outputs is set up in the range of the upper limit which was set up according to the value which filtered input-signal reinforcement with the low pass filter 32, and was defined, and a lower limit. By the above-mentioned configuration, even when phasing speed is slow, it can change in the suitable range and a threshold can be set up, and the fall of diversity gain can be suppressed.
[0005]
[Problem(s) to be Solved by the Invention] However, since it cannot judge how much level of noises, such as an interference wave contained in an input signal, there are with the above-mentioned configuration, even if it is the case that the level of the noise contained in an input signal is high, there is a problem which judges that input-signal reinforcement is high and performs an antenna change. In the frequency

band with which much communication system was intermingled like the ISM band (2.4GHz band) used for small power data telecommunication systems, such as wireless LAN, such a problem becomes still more serious in order to tend to cause interference mutually. Moreover, in antenna change diversity, since it changes in case aerial connection is changed in an antenna changer, and an excessive noise occurs, if an antenna change is performed at the time of transmission and reception of data, deterioration of a signal-to-noise power ratio (SNR) will pose a problem.
[0006] Then, this invention solves the above-mentioned trouble and let it be a technical problem to propose diversity reception equipment excellent in interference resistance with a simple configuration. Moreover, let it be a technical problem for this invention to control deterioration of SNR accompanying an antenna change by performing timing of an antenna change into a guard time.
[0007]
[Means for Solving the Problem] In order to solve the above-mentioned technical problem diversity reception equipment of this invention An antenna changer which chooses any or 1 of two or more antennas for carrying out diversity reception of the electric wave, and two or more antennas, and performs a connection change, The recovery section which restores to a radio signal obtained through an antenna connected by antenna changer, and acquires a spectrum diffusion signal, A correlation value detection means to calculate a correlation value of said spectrum diffusion signal and diffusion sign, The averaging section which calculates the average per frame of the maximum correlation value which a correlation value detection means outputs, A threshold beforehand determined as said average which the averaging section outputs is compared, and it has a level comparator which outputs a control signal for controlling an antenna change in an antenna changer to an antenna changer. Since an antenna change is controlled by this configuration on the basis of the average per frame of the maximum correlation value which a correlation value detection means outputs, an antenna change in consideration of a signal-to-noise power ratio is attained, and diversity reception equipment excellent in interference resistance can be offered with a simple configuration.
[0008] Moreover, in a configuration of the above [diversity reception equipment of this invention], an antenna changer changes an antenna into a guard time contained in a frame. By this configuration, diversity reception equipment which can control deterioration of SNR accompanying an antenna change can be offered.
[0009]
[Embodiment of the Invention] Hereafter, the gestalt of this operation is explained with reference to each drawing.
[0010] Drawing 1 is the block block diagram of the diversity reception equipment of this invention, and is used for the spread spectrum direct sequence communication system of a TDD method. As shown in this drawing, diversity reception equipment is equipped with an antenna 11, an antenna 12, an antenna changer 13, a demodulator 14, A/D converter 15, the digital matched filter (DMF) 16, the data judging section 17, the maximum correlation value detecting element 18, the clock playback section 19, the frame separation section 20, the average value calculation section 21, a level comparator 22, and a control section 23.
[0011] In a spread spectrum direct sequence communication link, the product of the diffusion sign is carried out to the data which should be transmitted, and the spectrum diffusion signal of baseband is generated. A transmitter sends out the radio signal which modulated the carrier by this baseband spectrum diffusion signal (chip data). The electric wave sent out from the transmitter arrives at antennas 11 and 12. A demodulator 14 restores to the radio signal which received through the antenna chosen by the antenna changer 13, and acquires the baseband spectrum diffusion signal of an analog. With A/D converter 15, A/D conversion of the baseband spectrum diffusion signal of an analog is carried out, and it turns into a digitized baseband spectrum diffusion signal (chip data).
[0012] The digital matched filter 16 calculates the correlation value of the chip data outputted from A/D converter 15, and a diffusion sign with the same pattern as a transmitting side, and outputs the maximum correlation value on frequency equal to the bit rate of transmit data. The digital matched filters 16 are n delay elements 24-1, 24-2, —, 24-n and n multipliers 25-1, 25-2, —, 25-n and the digital filter which consists of adders 26, as shown in drawing 2 . A delay element 24-1, 24-2, —, 24-n consist of shift registers etc. Each multiplier 25-1, 25-2, —, the coefficient that has the phase of the same pattern as the diffusion sign of a transmitting side in 25-n are held. One by one, chip data carries out the product of the multiplier 25-1 corresponding to a delay element 24-1, 24-2, —, the value in each chip section of chip data

if inputted into 24–n and it, 25–2, —, the coefficient stored in 25–n, adds the whole of the result with an adder 26, and outputs a correlation value.

[0013] Coincidence of each pattern in the chip section of chip data and the pattern currently held at the multiplier 25 outputs the maximum correlation value from the digital matched filter 16. The maximum correlation value detecting element 18 will output a detection pulse signal to the clock playback section 19, if the maximum correlation value in the 1–bit section of a receiving baseband spectrum diffusion signal is detected. The clock playback section 19 reproduces a clock based on a detection pulse signal, and outputs it to the data judging section 17. By identifying the output value of the digital matched filter 16 to the clock timing which the clock playback section 19 outputs, the data judging section 17 reproduces transmit data. The reproduced bit data are incorporated as frame data by the frame separation section 20, and are supplied to each latter circuit.

[0014] Drawing 3 is explanatory drawing of a format of a receiving frame. A receiving frame contains a preamble (PR), a sync word (UW), data division (DATA), the auxiliary sign (AUX) for error detection, a card time (GT), etc. Even when a mobile station is in the cel radius distance from which a propagation delay serves as max, in order to secure the communication link by which the base station was stabilized within the frame period, a guard time is set up for a long time than the time amount which propagation of the signal in a radius twice the distance of a cel takes. The frame separation section 20 outputs the frame timing signal corresponding to a guard time to the average value calculation section 21 and a level comparator 22 for every frame. The average value calculation section 21 calculates the average value of a peak level by converting into per frame the level (peak level) of the maximum correlation value detected by the maximum correlation value detecting element 18, and outputs this average value to a level comparator 22. A level comparator 22 compares the threshold currently held at the control section 23 with the average value of the peak level outputted from the average value calculation section 21, and when the average value of a peak level is lower than a threshold, it outputs the control signal for changing an antenna based on a frame timing signal to an antenna changer 13.

[0015] Drawing 4 is the graph of the result of having carried out computer simulation of the relation between the average per frame of the peak level which the maximum correlation value detecting element 18 detects, and SNR of an input signal. As shown in this drawing, it is possible to obtain SNR based on the average of a peak level. Moreover, drawing 5 is the graph of the result of having carried out computer simulation of the relation between the average of a peak level, and probability density, and can ask for a bit error rate (BER) using SNR obtained from the average of a peak level. thus, in this invention, in order not to perform an antenna change on the basis of the level of an input signal like the conventional technology, but to presume SNR of an input signal on the basis of the average per frame of the peak level outputted from the digital matched filter 16 and to perform an antenna change, the antenna change diversity reception equipment which was extremely excellent in interference resistance is realized — things are made.

[0016] Moreover, in the diversity reception equipment shown in drawing 1 , since the configuration of those other than average value calculation section 21, level comparator 22, and threshold setting section 23 is the same as the configuration included in the conventional spectrum diffusion communication device, the antenna change diversity reception equipment which was excellent in interference resistance with a comparatively simple configuration is realizable. Moreover, since an antenna changer 13 performs an antenna change to the timing of the guard time contained in a receiving frame, it can suppress generating of the change noise of an antenna. Moreover, selection with transmitting diversity and receiving diversity can be made by setting up in which guard time of a transmitting frame and a receiving frame a control section 23 performs an antenna change.

[0017]

[Effect of the Invention] Since an antenna change is controlled on the basis of the average per frame of the maximum correlation value which a correlation value detection means outputs according to this invention, the antenna change in consideration of a signal–to–noise power ratio is attained, and diversity reception equipment excellent in interference resistance can be offered with a simple configuration. Moreover, according to this invention, since an antenna change is performed into a guard time, the diversity reception equipment which can control deterioration of SNR accompanying an antenna change can be offered.

[Translation done.]

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TECHNICAL FIELD

[The technical field to which invention belongs] This invention relates to the antenna change diversity reception technology used for spread spectrum direct sequence communication system.

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PRIOR ART

[Description of the Prior Art] In the radio communications using a digital cellular phone, a land mobile radiotelephone, etc., an input signal causes the increment in a lifting and a digital error for the level variation and phase fluctuation which are about dozens of dB by phasing which originates under migration and multi-pass environment of a migration communication terminal. For this reason, technology, such as after [detection] change diversity and antenna change diversity, is proposed as technology for compensating the fall of receiving level. In the diversity after detection, it is the method which adopts the data which formed an antenna and two or more receivers which restore to the received electric wave and reproduce received data in the receiving set, performed data playback in each receiving network, and was most reproduced in the high receiving network of receiving level. However, since the change diversity after detection needs two or more receiving networks, it has the defect to which the configuration of a receiving set becomes complicated and a manufacturing cost becomes high. For this reason, it is unsuitable for the digital cellular phone as which low cost and a simple configuration are required.
[0003] Then, antenna change diversity is proposed as technology for realizing diversity with low cost and a simple configuration. An example of antenna change diversity reception technology is explained with reference to drawing 6 . The diversity reception equipment shown in this drawing is indicated by JP,2000-295150,A. In this drawing, the antenna changer to which signs 27 and 28 perform an antenna and 29 performs an antenna change, and 30 receive the electric wave from a base station through an antenna 27 or 28, are a receive section which gets over and outputs received data, and have the function to detect input-signal reinforcement. 31 is an antenna selection means and controls an antenna changer 29 according to the level of the input signal detected in the receive section 30. The antenna selection means 31 measures the low pass filter 32 which filters input-signal reinforcement, a threshold generating means 33 output the suitable change threshold over average input-signal reinforcement, and the change threshold and the input-signal reinforcement obtained from the threshold generating means 33, when input-signal reinforcement changes and it is less than a threshold, is equipped with a comparison means 34 control an antenna changer 29 to change an antenna, and is constituted.
[0004] What has the cut off frequency of the Doppler change frequency degree which produces a low pass filter 32 on a received wave with the passing speed of a walking speed degree is used. The change threshold which the threshold generating means 33 outputs is set up in the range of the upper limit which was set up according to the value which filtered input-signal reinforcement with the low pass filter 32, and was defined, and a lower limit. By the above-mentioned configuration, even when phasing speed is slow, it can change in the suitable range and a threshold can be set up, and the fall of diversity gain can be suppressed.

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EFFECT OF THE INVENTION

[Effect of the Invention] Since an antenna change is controlled on the basis of the average per frame of the maximum correlation value which a correlation value detection means outputs according to this invention, the antenna change in consideration of a signal-to-noise power ratio is attained, and diversity reception equipment excellent in interference resistance can be offered with a simple configuration. Moreover, according to this invention, since an antenna change is performed into a guard time, the diversity reception equipment which can control deterioration of SNR accompanying an antenna change can be offered.

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TECHNICAL PROBLEM

[Problem(s) to be Solved by the Invention] However, since it cannot judge how much level of noises, such as an interference wave contained in an input signal, there are with the above-mentioned configuration, even if it is the case that the level of the noise contained in an input signal is high, there is a problem which judges that input-signal reinforcement is high and performs an antenna change. In the frequency band with which much communication system was intermingled like the ISM band (2.4GHz band) used for small power data telecommunication systems, such as wireless LAN, such a problem becomes still more serious in order to tend to cause interference mutually. Moreover, in antenna change diversity, since it changes in case aerial connection is changed in an antenna changer, and an excessive noise occurs, if an antenna change is performed at the time of transmission and reception of data, deterioration of a signal-to-noise power ratio (SNR) will pose a problem.
[0006] Then, this invention solves the above-mentioned trouble and let it be a technical problem to propose diversity reception equipment excellent in interference resistance with a simple configuration. Moreover, let it be a technical problem for this invention to control deterioration of SNR accompanying an antenna change by performing timing of an antenna change into a guard time.

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MEANS

[Means for Solving the Problem] In order to solve the above-mentioned technical problem diversity reception equipment of this invention An antenna changer which chooses any or 1 of two or more antennas for carrying out diversity reception of the electric wave, and two or more antennas, and performs a connection change, The recovery section which restores to a radio signal obtained through an antenna connected by antenna changer, and acquires a spectrum diffusion signal, A correlation value detection means to calculate a correlation value of said spectrum diffusion signal and diffusion sign, The averaging section which calculates the average per frame of the maximum correlation value which a correlation value detection means outputs, A threshold beforehand determined as said average which the averaging section outputs is compared, and it has a level comparator which outputs a control signal for controlling an antenna change in an antenna changer to an antenna changer. Since an antenna change is controlled by this configuration on the basis of the average per frame of the maximum correlation value which a correlation value detection means outputs, an antenna change in consideration of a signal-to-noise power ratio is attained, and diversity reception equipment excellent in interference resistance can be offered with a simple configuration.
[0008] Moreover, in a configuration of the above [diversity reception equipment of this invention], an antenna changer changes an antenna into a guard time contained in a frame. By this configuration, diversity reception equipment which can control deterioration of SNR accompanying an antenna change can be offered.
[0009]
[Embodiment of the Invention] Hereafter, the gestalt of this operation is explained with reference to each drawing.
[0010] Drawing 1 is the block block diagram of the diversity reception equipment of this invention, and is used for the spread spectrum direct sequence communication system of a TDD method. As shown in this drawing, diversity reception equipment is equipped with an antenna 11, an antenna 12, an antenna changer 13, a demodulator 14, A/D converter 15, the digital matched filter (DMF) 16, the data judging section 17, the maximum correlation value detecting element 18, the clock playback section 19, the frame separation section 20, the average value calculation section 21, a level comparator 22, and a control section 23.
[0011] In a spread spectrum direct sequence communication link, the product of the diffusion sign is carried out to the data which should be transmitted, and the spectrum diffusion signal of baseband is generated. A transmitter sends out the radio signal which modulated the carrier by this baseband spectrum diffusion signal (chip data). The electric wave sent out from the transmitter arrives at antennas 11 and 12. A demodulator 14 restores to the radio signal which received through the antenna chosen by the antenna changer 13, and acquires the baseband spectrum diffusion signal of an analog. With A/D converter 15, A/D conversion of the baseband spectrum diffusion signal of an analog is carried out, and it turns into a digitized baseband spectrum diffusion signal (chip data).
[0012] The digital matched filter 16 calculates the correlation value of the chip data outputted from A/D converter 15, and a diffusion sign with the same pattern as a transmitting side, and outputs the maximum correlation value on frequency equal to the bit rate of transmit data. The digital matched filters 16 are n delay elements 24-1, 24-2, --, 24-n and n multipliers 25-1, 25-2, --, 25-n and the digital filter which consists of adders 26, as shown in drawing 2 . A delay element 24-1, 24-2, --, 24-n consist of shift registers etc. Each multiplier 25-1, 25-2, --, the coefficient that has the phase of the same pattern as the diffusion sign of a transmitting side in 25-n are held. One by one, chip data carries out the product of the

multiplier 25-1 corresponding to a delay element 24-1, 24-2, --, the value in each chip section of chip data if inputted into 24-n and it, 25-2, --, the coefficient stored in 25-n, adds the whole of the result with an adder 26, and outputs a correlation value.

[0013] Coincidence of each pattern in the chip section of chip data and the pattern currently held at the multiplier 25 outputs the maximum correlation value from the digital matched filter 16. The maximum correlation value detecting element 18 will output a detection pulse signal to the clock playback section 19, if the maximum correlation value in the 1-bit section of a receiving baseband spectrum diffusion signal is detected. The clock playback section 19 reproduces a clock based on a detection pulse signal, and outputs it to the data judging section 17. By identifying the output value of the digital matched filter 16 to the clock timing which the clock playback section 19 outputs, the data judging section 17 reproduces transmit data. The reproduced bit data are incorporated as frame data by the frame separation section 20, and are supplied to each latter circuit.

[0014] Drawing 3 is explanatory drawing of a format of a receiving frame. A receiving frame contains a preamble (PR), a sync word (UW), data division (DATA), the auxiliary sign (AUX) for error detection, a card time (GT), etc. Even when a mobile station is in the cel radius distance from which a propagation delay serves as max, in order to secure the communication link by which the base station was stabilized within the frame period, a guard time is set up for a long time than the time amount which propagation of the signal in a radius twice the distance of a cel takes. The frame separation section 20 outputs the frame timing signal corresponding to a guard time to the average value calculation section 21 and a level comparator 22 for every frame. The average value calculation section 21 calculates the average value of a peak level by converting into per frame the level (peak level) of the maximum correlation value detected by the maximum correlation value detecting element 18, and outputs this average value to a level comparator 22. A level comparator 22 compares the threshold currently held at the control section 23 with the average value of the peak level outputted from the average value calculation section 21, and when the average value of a peak level is lower than a threshold, it outputs the control signal for changing an antenna based on a frame timing signal to an antenna changer 13.

[0015] Drawing 4 is the graph of the result of having carried out computer simulation of the relation between the average per frame of the peak level which the maximum correlation value detecting element 18 detects, and SNR of an input signal. As shown in this drawing, it is possible to obtain SNR based on the average of a peak level. Moreover, drawing 5 is the graph of the result of having carried out computer simulation of the relation between the average of a peak level, and probability density, and can ask for a bit error rate (BER) using SNR obtained from the average of a peak level. thus, in this invention, in order not to perform an antenna change on the basis of the level of an input signal like the conventional technology, but to presume SNR of an input signal on the basis of the average per frame of the peak level outputted from the digital matched filter 16 and to perform an antenna change, the antenna change diversity reception equipment which was extremely excellent in interference resistance is realized -- things are made.

[0016] Moreover, in the diversity reception equipment shown in drawing 1 , since the configuration of those other than average value calculation section 21, level comparator 22, and threshold setting section 23 is the same as the configuration included in the conventional spectrum diffusion communication device, the antenna change diversity reception equipment which was excellent in interference resistance with a comparatively simple configuration is realizable. Moreover, since an antenna changer 13 performs an antenna change to the timing of the guard time contained in a receiving frame, it can suppress generating of the change noise of an antenna. Moreover, selection with transmitting diversity and receiving diversity can be made by setting up in which guard time of a transmitting frame and a receiving frame a control section 23 performs an antenna change.

[Translation done.]

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DESCRIPTION OF DRAWINGS

[Brief Description of the Drawings]
[Drawing 1] It is the block block diagram of the diversity reception equipment of this invention.
[Drawing 2] It is the block diagram of a digital matched filter.
[Drawing 3] It is format drawing of a receiving frame.
[Drawing 4] It is the graph of the average of a SNR pair peak level.
[Drawing 5] It is the graph of the average pair probability density distribution of a peak level.
[Drawing 6] It is the block block diagram of the diversity reception equipment in the conventional technology.
[Description of Notations]
11 [— An A/D converter, 16 / — A digital matched filter, 17 / — The data judging section, 18 / — The maximum correlation value detecting element 19 / — The clock playback section, 20 / — The frame separation section, 21 / — The average value calculation section, 22 / — A level comparator, 23 / — A control section, 24 / — A delay element, 25 / — A multiplier, 26 / — Adder] — An antenna, 12 — antenna, 13 — An antenna changer, 14 — A demodulator,

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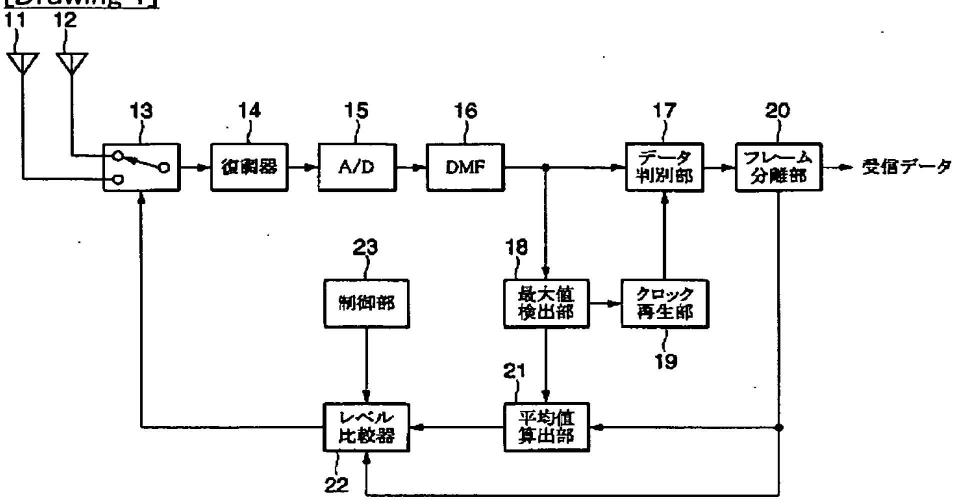
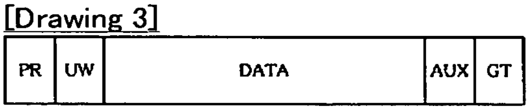
DRAWINGS

[Drawing 1]

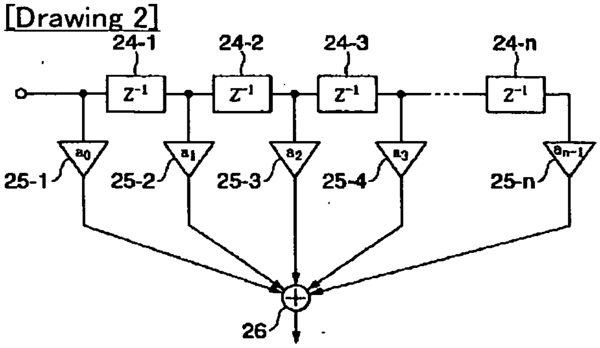


[Drawing 3]

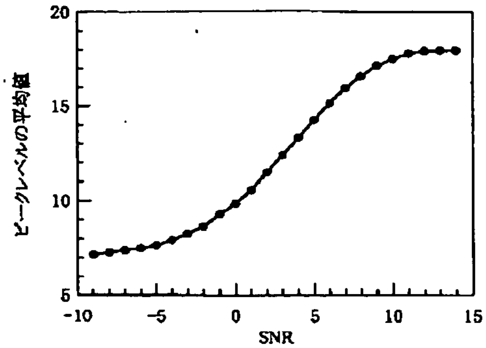


PR:プリアンブル
UW:同期語
DATA:データ部
AUX:誤り検出用補助符号
GT:ガードタイム

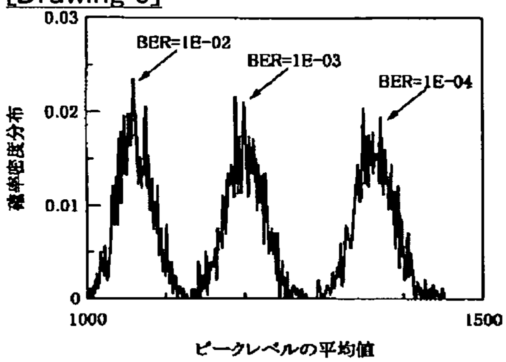
[Drawing 2]



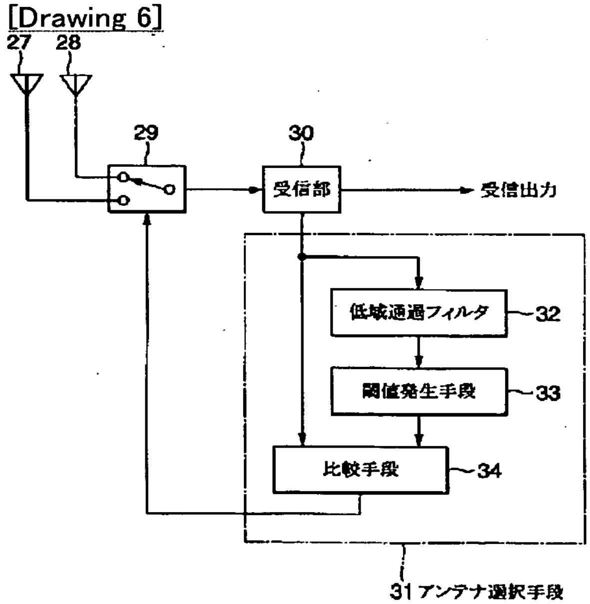
[Drawing 4]



[Drawing 5]



[Drawing 6]



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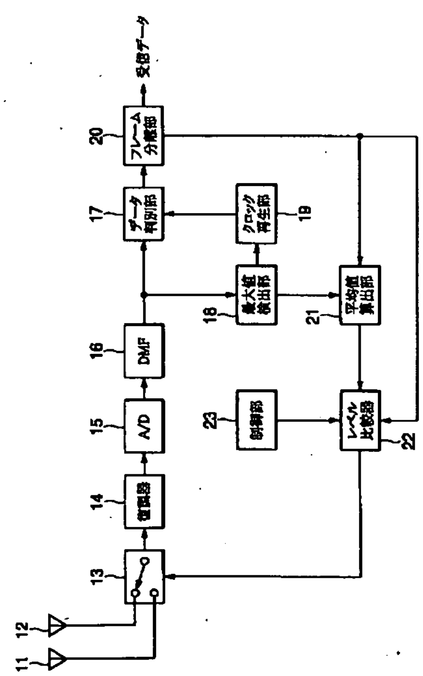
(54)【発明の名称】　ダイバーシチ受信装置

(57)【要約】

【課題】　干渉耐性に優れたダイバーシチ受信装置を簡易な構成で提供する。

【解決手段】　本発明のダイバーシチ受信装置はの複数のアンテナ（１１，１２）と、複数のアンテナ（１１，１２）のうち何れか１つを選択して接続切替えを行うアンテナ切替え器（１３）と、無線信号を復調し、ベースバンドスペクトラム拡散信号を得る復調器（１４）と、該ベースバンドスペクトラム拡散信号をＡ／Ｄ変換してチップデータを生成するＡ／Ｄ変換器（１５）と、チップデータと拡散符号との相関値を求めるデジタルマッチドフィルタ（１６）と、最大相関値を検出する最大相関値検出部（１８）と、最大相関値の１フレーム当たりの平均値を求める平均値算出部（２１）と、前記平均値と予め定められた閾値とを比較し、アンテナ切替え器（１３）におけるアンテナ切替えを制御するための制御信号をアンテナ切替え器（１３）に出力するレベル比較器（２２）とを備える。



１

【特許請求の範囲】

【請求項１】　電波をダイバーシチ受信するための複数のアンテナと、複数のアンテナのうち何れか１つを選択して接続切替えを行うアンテナ切替え器と、アンテナ切替え器によって接続されたアンテナを介して得られる無線信号を復調し、スペクトラム拡散信号を得る復調部と、前記スペクトラム拡散信号と拡散符号との相関値を求める相関値検出手段と、相関値検出手段が出力する最大相関値の１フレーム当たりの平均値を求める平均値算出部と、平均値算出部が出力する前記平均値と予め定められた閾値とを比較し、アンテナ切替え器におけるアンテナ切替えを制御するための制御信号をアンテナ切替え器に出力するレベル比較器とを備えた、ダイバーシチ受信装置。

【請求項２】　前記アンテナ切替え器はフレームに含まれるガードタイム中にアンテナの切替えを行う、請求項１に記載のダイバーシチ受信装置。

【請求項３】　前記相関値検出手段はデジタルマッチドフィルタである、請求項１又は請求項２に記載のダイバーシチ受信装置。

【発明の詳細な説明】

【０００１】

【発明の属する技術分野】本発明はスペクトラム直接拡散通信システムに用いられるアンテナ切替ダイバーシチ受信技術に関する。

【０００２】

【従来の技術】デジタル携帯電話や自動車電話等を利用した無線通信では移動通信端末の移動やマルチパス環境下に起因するフェージングにより、受信信号が数十ｄＢ程度のレベル変動と位相変動を起こし、符号誤りの増加を引き起こす。このため、受信レベルの低下を補償するための技術として、検波後切替ダイバーシチ、アンテナ切替ダイバーシチ等の技術が提案されている。検波後ダイバーシチではアンテナと、受信した電波を復調し受信データを再生する受信機とを受信装置内に２系統以上設け、各々の受信系統でデータ再生を行い、最も受信レベルの高い受信系統で再生したデータを採用する方式である。しかし、検波後切替ダイバーシチは受信系統を２系統以上必要とするため、受信装置の構成が複雑となり、製造コストが高くなる欠点を有している。このため、低コスト且つ簡易な構成が要求されるデジタル携帯電話には不向きである。

【０００３】そこで、ダイバーシチを低コスト且つ簡易な構成で実現するための技術として、アンテナ切替ダイバーシチが提案されている。アンテナ切替ダイバーシチ受信技術の一例を、図６を参照して説明する。同図に示すダイバーシチ受信装置は特開２０００－２９５１５０に開示されているものである。同図において、符号２７，２８はアンテナ、２９はアンテナ切替えを行うアンテナ切替え器、３０はアンテナ２７又は２８を介して基

２

地局からの電波を受信し、復調して受信データを出力する受信部であり、受信信号強度を検出する機能を有している。３１はアンテナ選択手段であり、受信部３０で検出された受信信号のレベルに応じてアンテナ切替え器２９を制御する。アンテナ選択手段３１は受信信号強度を濾波する低域通過フィルタ３２と、平均受信信号強度に対する適切な替え閾値を出力する閾値発生手段３３と、閾値発生手段３３から得られる切替え閾値と受信信号強度とを比較し、受信信号強度が切替え閾値を下回った場合にアンテナを切替えるようにアンテナ切替え器２９を制御する比較手段３４とを備えて構成されている。

【０００４】低域通過フィルタ３２は歩行速度程度の移動速度によって受信波に生じるドップラー変移周波数程度のカットオフ周波数を有するものが用いられる。閾値発生手段３３が出力する切替え閾値は、受信信号強度を低域通過フィルタ３２により濾波した値に応じて設定され、且つ定められた上限値及び下限値の範囲で設定される。上記の構成により、フェージング速度が遅いときでも適切な範囲で切替え閾値を設定することができ、ダイバーシチ利得の低下を抑えることができる。

【０００５】

【発明が解決しようとする課題】しかし、上記の構成では、受信信号に含まれる干渉波等のノイズのレベルがどの程度あるかを判断できないため、受信信号に含まれるノイズのレベルが高い場合であっても、受信信号強度が高いと判断してアンテナ切替えを行ってしまう問題がある。このような問題は、ワイヤレスＬＡＮ等の小電力データ通信システムに利用されているＩＳＭバンド（２．４ＧＨz帯）のように多くの通信システムが混在した周波数帯では相互に干渉を起こし易いため、さらに深刻となる。また、アンテナ切替ダイバーシチでは、アンテナ切替え器においてアンテナ接続を切替える際に切替え過度雑音が発生するため、データの送受信時にアンテナ切替えを行うと信号対雑音電力比（ＳＮＲ）の劣化が問題となる。

【０００６】そこで、本発明は上記の問題点を解決し、干渉耐性に優れたダイバーシチ受信装置を簡易な構成で提案することを課題とする。また、本発明はアンテナ切替えのタイミングをガードタイム中に行うことにより、アンテナ切替えに伴うＳＮＲの劣化を抑制することを課題とする。

【０００７】

【課題を解決するための手段】上記の課題を解決するべく本発明のダイバーシチ受信装置は、電波をダイバーシチ受信するための複数のアンテナと、複数のアンテナのうち何れか１つを選択して接続切替えを行うアンテナ切替え器と、アンテナ切替え器によって接続されたアンテナを介して得られる無線信号を復調し、スペクトラム拡散信号を得る復調部と、前記スペクトラム拡散信号と拡散符号との相関値を求める相関値検出手段と、相関値検

出手段が出力する最大相関値の１フレーム当たりの平均値を求める平均値算出部と、平均値算出部が出力する前記平均値と予め定められた閾値とを比較し、アンテナ切替え器におけるアンテナ切替えを制御するための制御信号をアンテナ切替え器に出力するレベル比較器とを備える。かかる構成により、相関値検出手段が出力する最大相関値の１フレーム当たりの平均値を基準にアンテナ切替えを制御するため、信号対雑音電力比を考慮したアンテナ切替えが可能となり、干渉耐性に優れたダイバーシチ受信装置を簡易な構成で提供することができる。

【０００８】また、本発明のダイバーシチ受信装置は上記の構成において、アンテナ切替え器はフレームに含まれるガードタイム中にアンテナの切替えを行う。かかる構成により、アンテナ切替えに伴うＳＮＲの劣化を抑制できるダイバーシチ受信装置を提供することができる。

【０００９】

【発明の実施の形態】以下、各図を参照して本実施の形態について説明する。

【００１０】図１は本発明のダイバーシチ受信装置のブロック構成図であり、ＴＤＤ方式のスペクトラム直接拡散通信システムに用いられる。同図に示すように、ダイバーシチ受信装置はアンテナ１１、アンテナ１２、アンテナ切替え器１３、復調器１４、Ａ／Ｄ変換器１５、デジタルマッチドフィルタ（ＤＭＦ）１６、データ判定部１７、最大相関値検出部１８、クロック再生部１９、フレーム分離部２０、平均値算出部２１、レベル比較器２２、及び制御部２３を備える。

【００１１】スペクトラム直接拡散通信では送信すべきデータに拡散符号が乗積されてベースバンドのスペクトラム拡散信号が生成される。送信機はこのベースバンドスペクトラム拡散信号（チップデータ）でキャリアを変調した無線信号を送出する。送信機から送出された電波はアンテナ１１，１２に到来する。復調器１４はアンテナ切替え器１３によって選択されたアンテナを介して受信した無線信号を復調し、アナログのベースバンドスペクトラム拡散信号を得る。アナログのベースバンドスペクトラム拡散信号はＡ／Ｄ変換器１５によって、Ａ／Ｄ変換され、デジタル化したベースバンドスペクトラム拡散信号（チップデータ）となる。

【００１２】デジタルマッチドフィルタ１６はＡ／Ｄ変換器１５から出力されるチップデータと、送信側と同一のパターンをもつ拡散符号との相関値を求め、送信データのビットレートに等しい周波数で最大相関値を出力する。デジタルマッチドフィルタ１６は、図２に示すように、ｎ個の遅延素子２４－１，２４－２，…，２４－ｎ、ｎ個の乗算器２５－１，２５－２，…，２５－ｎ、及び加算器２６から構成されるデジタルフィルタである。遅延素子２４－１，２４－２，…，２４－ｎはシフトレジスタ等から構成される。各々の乗算器２５－１，２５－２，…，２５－ｎには送信側の拡散符号と同一のパターンの位相をもつ係数が保持されている。チップデータが順次、遅延素子２４－１，２４－２，…，２４－ｎに入力されると、チップデータの各チップ区間における値とそれに対応した乗算器２５－１，２５－２，…，２５－ｎに格納された係数とを乗積し、その結果を全て加算器２６により加算し、相関値を出力する。

【００１３】チップデータのチップ区間における各々のパターンと、乗算器２５に保持されているパターンとが一致すると、デジタルマッチドフィルタ１６から最大相関値が出力される。最大相関値検出部１８は受信ベースバンドスペクトラム拡散信号の１ビット区間における最大相関値を検出すると、検出パルス信号をクロック再生部１９に出力する。クロック再生部１９は検出パルス信号を基にクロックを再生し、データ判定部１７に出力する。データ判定部１７はクロック再生部１９が出力するクロックタイミングでデジタルマッチドフィルタ１６の出力値を識別することにより、送信データの再生を行う。再生したビットデータはフレーム分離部２０によって、フレームデータとして取り込まれ、後段の各回路へ供給される。

【００１４】図３は受信フレームのフォーマットの説明図である。受信フレームはプリアンブル（ＰＲ）、同期語（ＵＷ）、データ部（ＤＡＴＡ）、誤り検出用補助符号（ＡＵＸ）、及びガードタイム（ＧＴ）等を含む。伝播遅延が最大となるセル半径距離に移動局がある場合でも、基地局がフレーム周期内で安定した通信を確保するため、ガードタイムはセル半径の倍の距離における信号の伝播に要する時間よりも長く設定される。フレーム分離部２０は各フレーム毎に、ガードタイムに対応したフレームタイミング信号を平均値算出部２１、及びレベル比較器２２に出力する。平均値算出部２１は最大相関値検出部１８によって検出された最大相関値のレベル（ピークレベル）を１フレーム当たりに換算することでピークレベルの平均値を求め、この平均値をレベル比較器２２へ出力する。レベル比較器２２は制御部２３に保持されている閾値と、平均値算出部２１から出力されるピークレベルの平均値とを比較し、ピークレベルの平均値が閾値よりも低い場合には、フレームタイミング信号を基にアンテナの切替えを行うための制御信号をアンテナ切替え器１３に出力する。

【００１５】図４は最大相関値検出部１８が検出するピークレベルの１フレーム当たりの平均値と、受信信号のＳＮＲとの関係を計算機シミュレーションした結果のグラフである。同図に示すように、ピークレベルの平均値を基にＳＮＲを得ることが可能である。また、図５はピークレベルの平均値と確率密度との関係を計算機シミュレーションした結果のグラフであり、ピークレベルの平均値から得たＳＮＲを用いてビットエラーレート（ＢＥＲ）を求めることができる。このように、本発明では従来技術のように受信信号のレベルを基準にアンテナ切替

えを行うのではなく、デジタルマッチドフィルタ１６から出力されるピークレベルの１フレーム当たりの平均値を基準に受信信号のＳＮＲを推定してアンテナ切替えを行うため、干渉耐性に極めて優れたアンテナ切替えダイバーシチ受信装置を実現することができる。

【００１６】また、図１に示したダイバーシチ受信装置において、平均値算出部２１、レベル比較器２２、及び閾値設定部２３以外の構成は従来のスペクトラム拡散通信装置に含まれている構成と同様であるため、比較的簡易な構成で干渉耐性に優れたアンテナ切替えダイバーシチ受信装置を実現することができる。また、アンテナ切替え器１３は受信フレームに含まれるガードタイムのタイミングでアンテナ切替えを行うため、アンテナの切替え雑音の発生を抑えることができる。また、制御部２３は送信フレームと受信フレームのどちらのガードタイムでアンテナ切替えを行うかを設定することにより、送信ダイバーシチと受信ダイバーシチとの選択をすることができる。

【００１７】

【発明の効果】本発明によれば、相関値検出手段が出力する最大相関値の１フレーム当たりの平均値を基準にアンテナ切替えを制御するため、信号対雑音電力比を考慮したアンテナ切替えが可能となり、干渉耐性に優れたダイバーシチ受信装置を簡易な構成で提供することができ＊

＊る。また、本発明によれば、ガードタイム中にアンテナ切替えを行うため、アンテナ切替えに伴うＳＮＲの劣化を抑制できるダイバーシチ受信装置を提供することができる。

【図面の簡単な説明】

【図１】本発明のダイバーシチ受信装置のブロック構成図である。

【図２】デジタルマッチドフィルタの構成図である。

【図３】受信フレームのフォーマット図である。

【図４】ＳＮＲ対ピークレベルの平均値のグラフである。

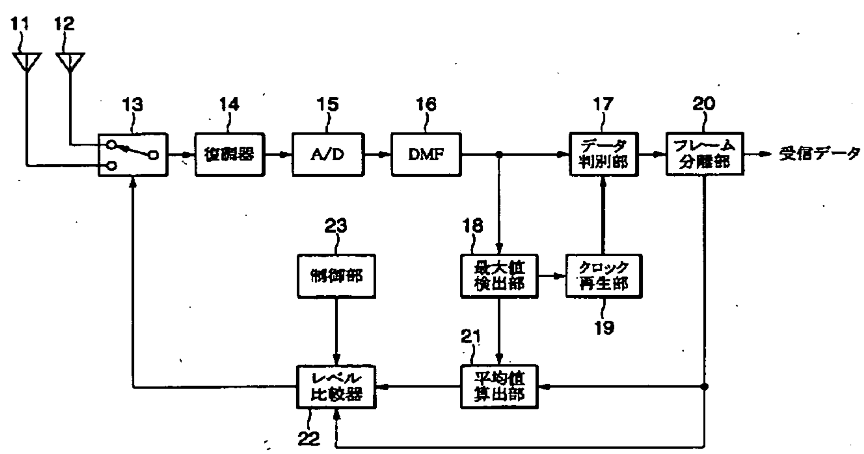
【図５】ピークレベルの平均値対確率密度分布のグラフである。

【図６】従来技術におけるダイバーシチ受信装置のブロック構成図である。

【符号の説明】

１１…アンテナ、１２…アンテナ、１３…アンテナ切替え器、１４…復調器、１５…Ａ／Ｄ変換器、１６…デジタルマッチドフィルタ、１７…データ判定部、１８…最大相関値検出部、１９…クロック再生部、２０…フレーム分離部、２１…平均値算出部、２２…レベル比較器、２３…制御部、２４…遅延素子、２５…乗算器、２６…加算器

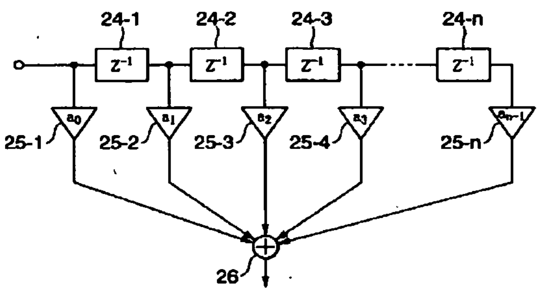
【図１】



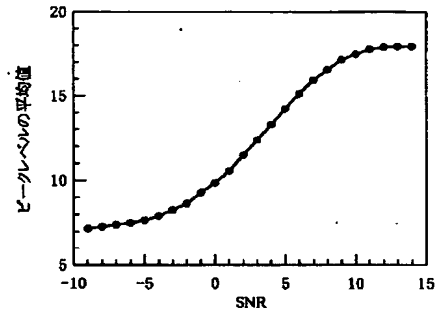
【図３】

PR:プリアンブル
UW:同期語
DATA:データ部
AUX:誤り検出用補助符号
GT:ガードタイム

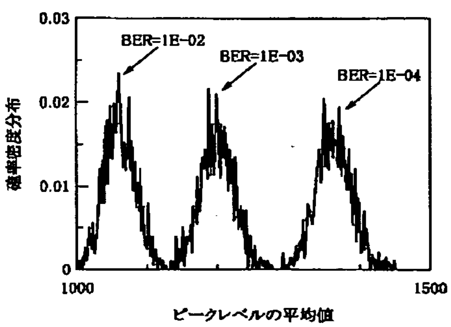
【図２】



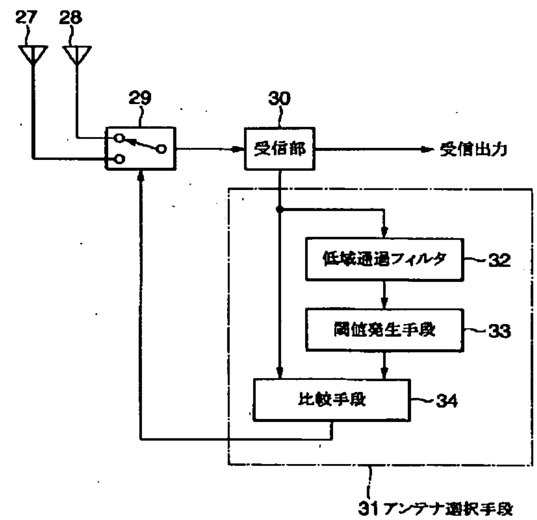
【図４】



【図５】



【図６】



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